

Reference Number = 2905405027

Application Number HEI 10-078315

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[Name of Document]	PATENT APPLICATION
[Reference Number]	2905405027
[Filing Date]	March 10, 1998
[To]	Commissioner, Patent Office
[International Patent Classification]	H04Q 7/22
[Title of the Invention]	TRANSMISSION POWER CONTROL METHOD AND TRANSMISSION/RECEPTION APPARATUS
[Number of Claims]	11
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[Prepayment Register Number]	041243
[Amount of Payment]	¥ 21,000
[List of Items Submitted]	
[Name of Item]	Specification 1
[Name of Item]	Drawing 1
[Name of Item]	Abstract 1
[Number of General Power of Attorney]	9700376

[NAME OF DOCUMENT] SPECIFICATION

[TITLE OF THE INVENTION] TRANSMISSION POWER CONTROL  
METHOD AND TRANSMISSION/RECEPTION APPARATUS

[SCOPE OF CLAIMS FOR PATENT]

5           [Claim 1] A transmission power control method,  
wherein first transmission power control is performed  
according to a transmission power control signal mixed  
into the reception signal, and if a base station is far  
from a mobile station, second transmission power control  
10 is performed to reduce the transmission power.

          [Claim 2] The transmission power control method  
according to claim 1, wherein the distance estimation  
in the second transmission power control is performed  
by estimating the reception quality of said received  
15 uplink signal or downlink signal, and if the estimated  
reception quality is low, the transmission power to the  
communication destination is reduced.

          [Claim 3] The transmission power control method  
according to claim 1, wherein the distance estimation  
20 in the second transmission power control is performed  
by measuring the reception power of said received uplink  
signal or downlink signal, and if the measured reception  
power is low, the transmission power to the communication  
destination is reduced.

25           [Claim 4] The transmission power control method  
according to claim 1, wherein the distance estimation  
in the second transmission power control is performed  
by measuring the time difference between the reception

timing of the reception signal and the transmission timing of the transmission signal, and if the measured time difference is large, the transmission power to the communication destination is reduced.

5           [Claim 5] A handover control method, wherein the total amount of transmission power during a handover is suppressed by using the transmission power control method described in any one of claim 1 to claim 4 during the handover.

10           [Claim 6] A transmission/reception apparatus comprising:

            first transmission power control means for carrying out transmission power control between a mobile station and base station according to a transmission power control  
15   signal mixed into a reception signal;

            reception quality estimation means for estimating the reception quality of the reception signal; and

            second transmission power control means for carrying out transmission power control to reduce the  
20   transmission power to said communication destination when said estimated reception quality is low.

            [Claim 7] A transmission/reception apparatus comprising:

            first transmission power control means for carrying  
25   out transmission power control between a mobile station and base station according to a transmission power control signal mixed into a reception signal;

            reception power measuring means for measuring the

reception power of the reception signal; and

second transmission power control means for carrying out transmission power control to reduce the transmission power to said communication destination when  
5 said measured reception power is low.

[Claim 8] A transmission/reception apparatus comprising:

first transmission power control means for carrying out transmission power control between a mobile station  
10 and base station according to a transmission power control signal mixed into a reception signal;

time difference measuring means for measuring a time difference between the reception timing of the reception signal and transmission timing of the transmission  
15 signal; and

second transmission power control means for carrying out transmission power control to reduce the transmission power to said communication destination when said measured time difference is large.

20 [Claim 9] The transmission/reception apparatus described in any one of claim 6 to claim 8, wherein transmission power control by said first transmission power control means and second transmission power control means is carried out by a single amplifier and at the  
25 same time a reduction of transmission power by said second transmission power control means is carried out by adjusting the offset value of said amplifier.

[Claim 10] A base station, wherein transmission

power control is carried out by the base station described in any one of claim 6 to claim 9 when a handover takes place.

[Claim 11] A mobile station, wherein transmission  
5 power is increased only when both a transmission power control signal received from a base station according to claim 10, the origin of movement when a handover takes place, and a transmission power control signal received from another base station according to claim 10, the  
10 destination of movement contain commands to increase transmission power.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical Field of the Invention]

15 The present invention relates to a transmission power control method and a transmission/reception apparatus to carry out CDMA communications. To be more specific, the present invention relates to a transmission power control method and a transmission/reception  
20 apparatus that optimally control the transmission power of the base station before and after a move when a soft handover takes place.

[0002]

[Prior Art]

25 A conventional transmission/reception apparatus carrying out handover control has a configuration shown below. FIG.6 are block diagrams showing an outline of conventional transmission/reception apparatus of mobile

station side, and transmission/reception apparatus of base station A and base station B side.

[0003]

The transmission/reception apparatus M of mobile station side comprises mobile station frame formatter 601, mobile station spreader 602, mobile station modulator 603, mobile station amplifier 604, mobile station duplexer 605, mobile station antenna 606, mobile station integrator 607, mobile station demodulator 608, mobile station despreader 609, mobile station RAKE combiner 610, mobile station SIR measurer 611 and mobile station AND operator 612.

[0004]

On the other hand, transmission/reception apparatus which constitutes base station A comprises base station A frame formatter 613, base station A spreader 614, base station A modulator 615, base station A amplifier 616, base station A duplexer 617, base station A antenna 618, base station A integrator 619, base station A demodulator 620, base station A despreader 621, base station A SIR measurer 622 and base station A RAKE combiner 23.

[0005]

Likewise, transmission/reception apparatus which constitutes base station B comprises base station B frame formatter 624, base station B spreader 625, base station B modulator 626, base station B amplifier 627, base station B duplexer 628, base station B antenna 629, base station B integrator 630, base station B demodulator 631, base

station B despreader 632, base station B SIR measurer 633 and base station B RAKE combiner 634.

[0006]

In communication according to the  
5 transmission/reception apparatus configured as shown  
above carry out a handover as shown in FIG.7 to FIG.10.  
FIG.7 is a schematic diagram showing how a handover takes  
place, FIG.8 shows the reception power of the mobile  
station without transmission power control, FIG.9 shows  
10 the transmission power of the base stations with  
transmission power control and FIG.10 shows the reception  
power of the mobile station carrying out transmission  
power control using conventional transmission/reception  
apparatuses.

15 [0007]

As shown in FIG.7, handover control is required when  
mobile station M moves from the area of base station A  
within the reach of radio waves of base station A to the  
area of base station B within the reach of radio waves  
20 of base station B. At this time, mobile station M must  
switch a communication with base station A to one with  
base station B. In this case, CDMA communications, etc.  
allow the mobile station to use a same frequency in  
neighboring areas, making a so-called soft handover  
25 possible, which is a way of realizing a seamless handover  
in a soft manner.

[0008]

When carrying out a handover, mobile station M

receives reception power  $R1$  (NPC.RA) with which the mobile station receives a signal transmitted from base station A without transmission power control and reception power  $R2$  (NPC.RB) with which the mobile station receives another  
5 signal transmitted from base station B without transmission power control, and combines both  $R1$  and  $R2$ . FIG.8 shows how this combination takes place. As shown in FIG.8, mobile station M combines reception power  $R1$  (NPC.RA) and reception power  $R2$  (NPC.RB) into reception  
10 power  $R3$  (NPC.RC). Through such a combination of reception signals, mobile station M can receive a signal with combined reception power  $R3$  (NPC.RC) with a quality exceeding the required level even on the cell boundary distant from both base stations.

15 [0009]

However, since the two base stations above do not carry out downlink transmission power control. This causes combined reception power  $R3$  (NPC.RC) of mobile station M to have an excessive quality exceeding the  
20 desired quality when mobile station M is near either base station A or base station B as shown in FIG.8. The right and left ends of combined reception power  $R3$  in FIG.8 show this situation. Thus, if the reception levels at the start and end of a handover have an excessive quality,  
25 signals transmitted from the base station to the mobile station may not only cause interference with communications of other users but also suppress the system capacity.



[0010]

For this reason, the base stations need to perform downlink transmission power control. That is, mobile station M sends transmission power control signals to base station A and base station B. Based on the transmitted base station control signals, base station A controls transmission power T1 (CPC.TA) and base station B controls transmission power T2 (CPC.TB). That is, transmission power T1 (CPC.TA) of base station A is controlled to be lower near base station A and transmission power T2 (CPC.TB) of base station B is controlled to be lower near base station B. FIG.9 shows this situation.

[0011]

By carrying out such transmission power control, reception power R1' (CPC.RA) at mobile station M of a signal transmitted by base station A and reception power R2' (CPC-RB) at mobile station M of another signal transmitted by base station B together constitute reception power R3' shown in FIG.10. Thus, by combining signals received from two base stations, combined reception power R3' (CPC.RC) at the mobile station matches the desired quality, making it possible to suppress excessive transmission power from the base stations and improve the system capacity.

[0012]

A conventional CDMA transmission system carrying out downlink transmission power control when mobile station M carries out a soft handover from the area of

base station A to the area of base station B is explained in detail with reference to FIG.6.

[0013]

Mobile station M sends TX\_DATA\_U1, an uplink  
5 transmission signal, to the base stations. Mobile station M carries out error correction coding on transmission signal TX\_DATA\_U1 by frame formatter 601. At the same time, mobile station M inserts a pilot symbol and transmission power control signal TPC\_DM for a  
10 downlink signal determined based on the result of SIR measurer 611 that estimates the quality of the downlink signal. Further, mobile station M spreads the output of frame formatter 1 by spreader 602, modulates by modulator 603, amplifies by amplifier 604, and then sends it from  
15 antenna 606 via duplexer 605. At this time, the amplification factor of amplifier 604 is controlled by the output of integrator 607.

[0014]

On the other hand, base station A inputs the signal  
20 received from antenna 618 via duplexer 617, demodulates by demodulator 620, processes by despreader 621 and RAKE combiner 623 and obtains reception signal RX\_DATA\_UA. Then, base station A estimates the reception quality of the uplink signal by SIR measurer 622 using the result  
25 of RAKE combiner 623 and determines the transmission power control level of the uplink signal based on this estimated value TPC\_UBA. Frame formatter 613 inserts a pilot signal and uplink signal transmission power control bit TPC\_UBA

into downlink signal TX\_DATA\_D subjected to error correction coding. Base station A spreads this signal by spreader 614, modulates by modulator 615, amplifies by amplifier 616 and transmits it from antenna 618 via  
5 duplexer 617. The amplification factor then is determined by a value obtained by integrator 619 integrating downlink transmission power control signal TPC\_DBA which was extracted by RAKE combiner 623. By the way, downlink transmission power control signal TPC\_DBA  
10 used at this time is the demodulated TPC\_DM that was inserted into the uplink signal by the mobile station. This is how base station A performs downlink transmission power control.

[0015]

15 Likewise, base station B inputs the signal received from antenna 629 via duplexer 628, demodulates by demodulator 631, processes by despreader 632 and RAKE combiner 634 and obtains reception signal RX\_DATA\_UB. At this time, base station B estimates the reception  
20 quality of the uplink signal by SIR measurer 633 using the result of RAKE combiner 634 and determines the transmission power control level of the unlink signal based on this estimated value TPC\_UBB. Frame formatter 624 inserts a pilot signal and uplink signal transmission  
25 power control bit TPC\_UBB into downlink signal TX\_DATA\_D subjected to error correction coding. TX\_DATA\_D is the same as TX\_DATA\_D of base station A. Base station B spreads this signal by spreader 625, modulates by

modulator 626, amplifies by amplifier 627 and transmits it from antenna 629 via duplexer 628. The amplification factor then is determined by a value obtained by integrator 630 integrating downlink transmission power control signal TPC\_DBB which was extracted by RAKE combiner 634. Downlink transmission power control signal TPC\_DBB used at this time is the demodulated TPC\_DM that was inserted into the uplink signal by the mobile station. This is how base station B performs downlink transmission power control.

[0016]

If there are no demodulation errors, TPC\_DBA and TPC\_DBB are the same, and therefore the same amplification factor of the downlink signal is used for base station A and base station B, hence the same increment/decrement control is performed. However, since their initial values of amplification factor are not always the same, the absolute values of amplification factor are not always the same.

[0017]

Mobile station M demodulates the signal received from antenna 606 via duplexer 605 by demodulator 608 and obtains received data RX\_DATA\_D via despreaders 609 and RAKE combiner 610. Furthermore, mobile station M estimates the quality of the downlink reception signal by SIR measurer 611 using the result of RAKE combiner 610 and determines downlink signal transmission power control bit TPC\_DM based on this estimated value.

Transmission power control of the downlink signal above is performed according to this signal. RAKE combiner 610 extracts the uplink transmission power control signals inserted into both the downlink signal from base station A and the uplink signal from base station B. TPC\_UMA is the extracted TPC\_UBA that was inserted by base station A and TPC\_UMB is the extracted TPC\_UBB that was inserted by base station B.

[0018]

10           Transmission power signals TPC\_UBA and TPC\_UBB have different values, but the transmission power of the uplink signal is increased only when both TPC\_UMA and TPC\_UMB have control to increase the transmission power through AND operator 612. Otherwise, mobile station M determines TPC\_UM, an input signal to integrator 607 so that the transmission power of the uplink signal is reduced. This prevents the uplink signal from having excessive transmission power at the time of a soft handover.

[0019]

20           As shown above, the conventional transmission/reception apparatus performs transmission power control for both the uplink signal and downlink signal at the time of a soft handover, which suppresses excessive transmission power within a certain range, preventing the system capacity from reducing.

[0020]

[Problems to be Solved by the Invention]

However, in the conventional

transmission/reception apparatus above, mobile station M inserts the same downlink signal transmission power control bit for both base station A that stays in the handover source area and base station B that stays in the handover destination area, and thus performs the same transmission power control. That is, although contributions of the reception signal from base station A and the reception signal from base station B to a combined reception signal at mobile station M are different at the beginning and at the end of the handover, both base station send signals with the same transmission power over the entire handover period. As a result, the transmission power at the beginning and at the end of the handover may constitute interference with other users and suppress the capacity of the communication system.

[0021]

The present invention has been made in consideration of the above-mentioned problem, and an objective of the present invention is to provide a transmission power control method and a transmission/reception apparatus capable of improving the system capacity by preventing transmissions with excessive transmission power during a soft handover and reducing total transmission power of the system while maintaining the reception quality at the receiving station.

[0022]

[Means for Solving the Problems]

In order to solve the above-mentioned problems, the

present invention uses the following means.

[0023]

The invention of the transmission power control method described in claim 1 adopts a method, wherein first  
5 transmission power control is performed according to a transmission power control signal mixed into the reception signal, and if a base station is far from a mobile station, second transmission power control is performed to reduce the transmission power.

10 [0024]

By this configuration, transmission power is made to reduce if a base station is far from a mobile station, whereby transmission is not executed in excessive transmission power, and the total transmission power of  
15 the system decreases, whereas the system capacity and transmission quality increase.

[0025]

In this case, the distance estimation in the second transmission power control is appropriately performed  
20 by estimating the reception quality of said received uplink signal or downlink signal as the invention described in claim 2, the distance estimation in the second transmission power control is performed by measuring the reception power of said received uplink signal or downlink  
25 signal as the invention described in claim 3, or the distance estimation in the second transmission power control is performed by measuring the time difference between the reception timing of the reception signal and

the transmission timing of the transmission signal as the invention described in claim 4.

[0026]

Also, the invention of the handover control method described in claim 5, adopts a method wherein, the total amount of transmission power during a handover is suppressed by using the transmission power control method described in any one of claim 1 to claim 4 during the handover.

10 [0027]

By this method, when the mobile station moves between cells, total transmission power of transmission power of both origin of movement and destination of movement is made to reduce, thus it is possible to improve capacity of system.

[0028]

The invention of the transmission/reception apparatus described in claim 6 adopts a configuration comprising first transmission power control means for carrying out transmission power control between a mobile station and base station according to a transmission power control signal mixed into a reception signal, reception quality estimation means for estimating the reception quality of the reception signal, and second transmission power control means for carrying out transmission power control to reduce the transmission power to the communication destination when the estimated reception quality is low.



[0029]

The invention of the transmission/reception apparatus described in claim 7 adopts a configuration comprising first transmission power control means for  
5 carrying out transmission power control between a mobile station and base station according to a transmission power control signal mixed into a reception signal, reception power measuring means for measuring the reception power of the reception signal, and second transmission power  
10 control means for carrying out transmission power control to reduce the transmission power to the communication destination when the measured reception power is low.

[0030]

The invention of the transmission/reception  
15 apparatus described in claim 8 adopts a configuration comprising first transmission power control means for carrying out transmission power control between a mobile station and base station according to a transmission power control signal mixed into a reception signal, time  
20 difference measuring means for measuring a time difference between the reception timing of the reception signal and transmission timing of the transmission signal, and second transmission power control means for carrying out transmission power control to reduce the transmission  
25 power to the communication destination when the measured time difference is large.

[0031]

By these configurations, when distance is far from

the communication partner, transmission power is made to reduce, whereby transmission with excessive transmission power is not executed, thus reception quality of reception station is maintained effectively and total transmission power of system is reduced, with the result that it is possible to improve capacity of system.

[0032]

The invention of the transmission/reception apparatus described in claim 9 adopts a configuration, wherein transmission power control by said first transmission power control means and second transmission power control means is carried out by a single amplifier and at the same time a reduction of transmission power by the second transmission power control means is carried out by adjusting the offset value of the amplifier.

[0033]

By this configuration, it is possible to execute transmission power control by the second transmission power control means without changing the first transmission power control means, and it is also possible to realize easily control of being reflected two kinds of transmission power control.

[0034]

The invention of the base station described in claim 10 adopts a configuration, wherein transmission power control is carried out by the base station described in any one of claim 6 to claim 9 when a handover takes place.

[0035]

Thus, base stations of both origin of movement and destination of movement are made to execute above-described transmission power control at the time  
5 handover is executed, so, it is possible to reduce total transmission power of the transmission power and to execute improvement of capacity of system.

[0036]

The invention of the mobile station described in  
10 claim 11 adopts a configuration, wherein transmission power is increased only when both a transmission power control signal received from a base station according to claim 10, the origin of movement when a handover takes place, and a transmission power control signal received  
15 from another base station according to claim 10, the destination of movement contain commands to increase transmission power.

[0037]

By this configuration, in cases where both distances  
20 from respective base stations are different at starting time of soft handover and end time thereof, it is possible to avoid situation in which transmission power is raised in accordance with transmission power control signal farer distance base station, thus farer distance base  
25 station's transmission power control becomes predominant, and transmission for the base station with excessive transmission power is not executed, whereby reception quality of reception station is maintained effectively

and total transmission power of system is reduced, thus it is possible to execute improvement of capacity of system.

[0038]

5 [Embodiments of the Invention]

(Embodiment 1)

With reference now to the attached drawings, a CDMA base station according to Embodiment 1 of the present invention is explained below. FIG.1 are block diagrams showing an outlined configuration of a system including transmission/reception apparatus according to Embodiment 1 of the present invention.

[0039]

Transmission/reception apparatus M of mobile station comprises mobile station frame formatter 101, mobile station spreader 102, mobile station modulator 103, mobile station amplifier 104, mobile station duplexer 105, mobile station antenna 106, mobile station integrator 107, mobile station demodulator 108, mobile station despreaders 109, mobile station RAKE combiner 110, mobile station SIR measurer 111 and mobile station AND operator 112.

[0040]

On the other hand, transmission/reception apparatus which constitutes base station A comprises base station A frame formatter 113, base station A spreader 114, base station A modulator 115, base station A amplifier 116, base station A duplexer 117, base station A antenna 118,

base station A integrator 119, base station A demodulator 120, base station A despreader 121, base station A SIR measurer 122 and base station A RAKE combiner 123, and further base station A offset adjuster 135.

5 [0041]

Likewise, transmission/reception apparatus which constitutes base station B comprises base station B frame formatter 124, base station B spreader 125, base station B modulator 126, base station B amplifier 127, base station B duplexer 128, base station B antenna 129, base station B integrator 130, base station B demodulator 131, base station B despreader 132, base station B SIR measurer 133 and base station B RAKE combiner 134, and further base station B offset adjuster 136.

15 [0042]

Transmission/reception apparatus of the present invention is that base station A offset adjuster 135 and base station B offset adjuster 136 are added to respective conventional fundamental configurations. Offset adjusters 135 and 136 have a function to adjust offset values of the amplification factors of amplifiers 116 and 117. In Embodiment 1, offset adjuster 135 at base station A controls the amplification factor taking into account both a value obtained by integrator 119 integrating the output from RAKE combiner 123 and the quality of the uplink signal estimated by SIR measurer 122. Likewise, offset adjuster 136 at base station B controls the amplification factor taking into account

both a value obtained by integrator 130 integrating the output from RAKE combiner 134 and the quality of the uplink signal estimated by SIR measurer 133.

[0043]

5           The transmission power control processing when a handover is carried out by base stations A and B above is explained in detail with reference to FIG.2 and FIG.3. FIG.2 is a schematic diagram of the transmission power of the base station of Embodiment 1 of the present invention  
10 and FIG.3 is a drawing showing the reception power level of mobile station M of Embodiment 1 of the present invention. In Embodiment 1, suppose a soft handover takes places when mobile station M moves from the area of base station A to the area of base station B.

15 [0044]

Mobile station M sends uplink signal TX\_DATA\_U1. First, frame formatter 101 carries out error correction coding on the transmission data, inserts a pilot symbol and inserts downlink signal transmission power control  
20 signal TPC\_DM determined based on the result of SIR measurer 111 that estimates the quality of the downlink signal. The output signal of this frame formatter 101 is spread by spreader 102, modulated by modulator 103, amplified by amplifier 104 and transmitted from antenna  
25 106 via duplexer 105. The amplification factor of amplifier 104 is controlled by integrator 107.

[0045]

Base station A separates the signal received from

antenna 118 by duplexer 117, demodulates by demodulator 120, subjects to signal processing by desreader 121 and RAKE combiner 123 and obtains reception signal RX\_DATA\_UA. At this time, SIR measurer 122 estimates the reception  
5 quality of the uplink signal using the output of RAKE combiner 123 and determines the transmission power control level of the uplink signal based on estimated value TPC\_UBA. The determined transmission power control level is inserted into downlink transmission  
10 signal TX\_DATA\_D as a transmission power control bit by frame formatter 113. The output signal of frame formatter 113 is spread by spreader 114, modulated by modulator 115, amplified by amplifier 116 and transmitted from antenna 118 via duplexer 117. The amplification factor  
15 of amplifier 116 is controlled by incrementing/decrementing the offset value of offset adjuster 135 to which a value obtained by integrator 119 integrating TPC\_DBA which was extracted by RAKE combiner 123, based on the quality of the uplink signal estimated  
20 by SIR measurer 122.

[0046]

To be more specific, if the quality of the uplink signal is not good, that is, if the output value of SIR measurer 122 is low, offset adjuster 135 determines that  
25 mobile station M is far from base station A and reduces the offset value to reduce the transmission power. On the contrary, if the quality of the uplink signal is good, that is, if the output value of SIR measurer 122 is high,

offset adjuster 135 determines that mobile station M is near base station A and increases the offset value.

[0047]

The SIR measured value used for offset adjustment is averaged to a certain degree so that it does not respond to instantaneous variations. Control over instantaneous variations is more effective than using the integration result of integrator 119 to which downlink transmission power control signal TPC\_DBA is input. This downlink transmission power control signal TPC\_DBA is obtained by demodulating TPC\_DM inserted to the uplink signal by the mobile station. This is how base station A performs downlink transmission power control. On the other hand, base station B separates the signal received from antenna 129 by duplexer 128, demodulates by demodulator 131, subjects to signal processing by despreaders 132 and RAKE combiner 134 and obtains reception signal RX\_DATA\_UB. At this time, SIR measurer 133 estimates the reception quality of the uplink signal using the output of RAKE combiner 134 and determines the transmission power control signal of the uplink signal based on estimated value TPC\_UBB. The determined transmission power control signal is inserted into downlink transmission signal TX\_DATA\_D as a transmission power control bit by frame formatter 124. As in the case of base station A, the output signal from the frame formatter is spread by spreader 125, modulated by modulator 126, amplified by amplifier 127 and transmitted



from antenna 129 via duplexer 128. The amplification factor of amplifier 127 is controlled, as in the case of base station A, by RAKE combiner 134, integrator 130 and SIR measurer 133, etc. An increment/decrement of  
5 offset values of offset adjuster 136 of base station B is also controlled in the same way as for base station A above.

[0048]

If the quality of the uplink signal is not good,  
10 that is, if the output value of SIR measurer 122 is low, offset adjuster 136 determines that mobile station M is far from base station B and reduces the offset value to reduce the transmission power. On the contrary, if the quality of the uplink signal is good, that is, if the  
15 output value of SIR measurer 122 is high, offset adjuster 136 determines that mobile station M is near base station B and increases the offset value.

[0049]

The SIR measured value used for offset adjustment  
20 is averaged to a certain degree so that it does not respond to instantaneous variations. Control over instantaneous variations is more effective than using the integration result of integrator 119 to which downlink transmission power control signal TPC\_DBA is input. This  
25 downlink transmission power control signal TPC\_DBA is obtained by demodulating TPC\_DM inserted to the uplink signal by the mobile station. That is, drastic transmission power variations can be suppressed by

incrementing/decrementing the previous transmission power by 1 dB according to transmission power control signal TPC\_DBA. This is how base station A performs downlink transmission power control. If there are no demodulation errors, TPC\_DBA matches TPC\_DBB, and the output of integrator 119 of base station A would originally match the output of integrator 130 of base station B. However, the amplification factor of the downlink signal of the amplifier of base station A and the amplification factor of the downlink signal of the amplifier of base station B are set to different values by the above control of offset adjusters 135 and 136.

[0050]

Offset adjusters 135 and 136 above have a configuration in which values of the uplink signal measured by SIR measurers 122 and 133 or those values converted by a table, etc. and then optimized are added to the outputs of integrators 119 and 130. This allows not only transmission power control common to all base stations using the TPC bit inserted into the uplink signal but also power control specific to each base station according to its distance from the mobile station. The table used for conversion of SIR measurement results are created by obtaining through simulation an optimum conversion function that will minimize the total transmission power of the system. Furthermore, offset adjusters 135 and 136 can multiply the outputs of integrators 119 and 130 by the results of SIR measurements,

etc. instead of adding the results of SIR measurements to the outputs of integrators 119 and 130. Offset adjusters 135 and 136 can also perform some linear processing or non-linear processing on the outputs of  
5 integrators 119 and 130 based on the SIR values.

[0051]

On the other hand, mobile station M receives the signal whose transmission power has been controlled as shown above from antenna 106, separates by duplexer 105,  
10 demodulates by demodulator 108, subjects it to signal processing by desreader 109 and RAKE combiner 110 and obtains reception signal RX\_DATA\_D. SIR measurer 111 estimates the quality of the downlink reception signal using the output of RAKE combiner 110 and determines  
15 downlink transmission power control signal TPC\_DM to be inserted into the uplink signal based on the estimated quality of the downlink reception signal. This is how downlink transmission power control is performed.

[0052]

20 Mobile station M further extracts the uplink transmission power control signal inserted into the downlink signal from the output of RAKE combiner 110. Uplink transmission power control signal TPC\_UMA is obtained by extracting control signal TPC\_UBA inserted  
25 by base station A from the downlink signal. Uplink transmission power control signal TPC\_UMB is obtained by extracting control signal TPC\_UBB inserted by base station B from the downlink signal.

[0053]

Uplink transmission power control signals TPC\_UMA and TPC\_UMB received from base station A and base station B, respectively have different values. Mobile station  
5 M carries out transmission power control to increase the transmission power of the uplink signal through AND operator 112 only when both control signals TPC\_UMA and TPC\_UMB have control to increase the transmission power. Otherwise, mobile station M determines control value  
10 TPC\_UM so that the transmission power of the uplink signal is decreased. Therefore, at the beginning or at the end of soft handover control, transmission power control of the farther base station becomes dominant, which prevents the uplink signal from the mobile station from having  
15 excessive transmission power.

[0054]

As described above, since it is possible to execute downlink transmission power control based on reception quality of uplink signal in every base station due to  
20 offset adjusters 135 and 136, the most effective transmission in transmission power becomes possible, thus it is possible to reduce total transmission power of the system, whereby it is possible to improve capacity of the system and transmission quality.

25 [0055]

In FIG.2, transmission power T1 (CPC\_TA) and transmission power T2 (CPC\_TB) represent transmission powers when base station A and base station B carry out

transmission power control according to the conventional method. In this case, less contribution of the combination by the mobile station is observed on the right side of transmission power T1 and left side of transmission power T2 despite the great power with which signals were sent.

[0056]

On the contrary, base station A and base station B carry out transmission power control above using offset adjusters 135 and 136. As a result, transmission power T1" of base station A and transmission power T2" of base station B decrease greatly at either the beginning or the end of a handover. Due to a drop of transmission power of either base station, the total transmission power of the system as a whole decreases.

[0057]

As illustrated in FIG.3, by using such transmission power control, in base stations A and B, although total transmission power is reduced as illustrated in FIG.2, in which the reception power combining these signals: reception power R1" and reception power R2" received from base stations A and B is shown as reception power R3" (PPC\_RC), reception power R3" at the mobile station has a uniform required quality as the reception power R3' (CPC\_RC) that is combined value at the mobile station when executing conventional transmission power control.

[0058]

(Embodiment 2)

A transmission/reception apparatus according to Embodiment 2 of the present invention is explained below with reference to the attached drawings. FIG.4 are block diagrams showing an outlined configuration of a system including a transmission/reception apparatus according to Embodiment 2 of the present invention.

[0059]

The configuration of the CDMA base station according to Embodiment 2 is basically the same as that of the transmission/reception apparatus in Embodiment 1, and therefore the same components are assigned the same numbers and their explanations are omitted. The difference from Embodiment 1 is that base stations A and B are provided with reception power measurers 401 and 402, respectively. The transmission/reception apparatus according to Embodiment 2 carries out measurements of the level of reception signals from a mobile station at the base stations not by SIR measurers but by reception power measurers 401 and 402. Reception power measurers 401 and 402 adjust the level of offset values of offset adjusters 135 and 136 according to these measurement results.

[0060]

That is, the amplification factor of downlink transmission signal TX\_DATA\_D is controlled by a value obtained by integrators 119 and 130 integrating transmission power control signal TPC\_DBA which was extracted by RAKE combiners 123 and 134 and the reception

power values of the uplink signal measured by reception power measurers 401 and 402.

[0061]

If the reception power of the uplink signal measured  
5 by reception power measurers 401 and 402 is small, mobile station M is judged to be far from base station A. In this case, base stations A and B reduce the offset values of offset adjusters 135 and 136 to reduce the amplification factor of amplifier 116, reducing the transmission power.  
10 On the contrary, if the reception power is large, mobile station M is judged to be near base station A and base stations A and B increase the offset values to increase the transmission power.

[0062]

15 The reception power measured values used for offset adjustment are averaged to a certain degree so that they do not respond to instantaneous variations. Control over the instantaneous variations has great effect when using result of integrators 119 and 130 integrating  
20 transmission power control signal TPC\_DBA, namely, control over instantaneous variations can be performed by suppressing drastic variations of the transmission power by incrementing/decrementing the previous transmission power by 1 dB according to transmission power  
25 control signal TPC\_DBA received.

[0063]

Thus, the base stations can perform more accurate downlink transmission power control through control by

the transmission power control signal received and offset control based on the reception power values measured by reception power measurers 401 and 402, transmission with the most effective transmission power becomes possible, since it is possible to reduce total transmission power, thus it is possible to improve system capacity and transmission quality.

[0064]

(Embodiment 3)

A transmission/reception apparatus according to Embodiment 3 of the present invention is explained below with reference to the attached drawings. FIG.5 are block diagrams showing an outlined configuration of a system including a transmission/reception apparatus according to Embodiment 3 of the present invention.

[0065]

The configuration of the CDMA base station according to Embodiment 3 is basically the same as that of the transmission/reception apparatus in Embodiment 1, and therefore the same components are assigned the same numbers and their explanations are omitted. The difference from Embodiment 1 is that base stations A and B are provided with time difference measurers 501 and 502, respectively. The transmission/reception apparatus according to Embodiment 3 carries out measurements of the level of reception signals from a mobile station at base stations not by SIR measurers but by time difference measurers 501 and 502. Time difference



measurers 501 and 502 adjust the level of offset values of offset adjusters 135 and 136 according to the measurement results.

[0066]

5           Transmission/reception operation among mobile station M, base station A and base station B is the same as that of the embodiment 1. Different point is that the amplification factor of downlink transmission signal TX\_DATA\_D is controlled by both a value obtained by  
10 integrators 119 and 130 integrating transmission power control signal TPC\_DBA which was extracted by RAKE combiners 123 and 134 and the time difference measured by time difference measurers 501 and 502.

[0067]

15           Specifically, the amplification factor of downlink transmission signal TX\_DATA\_D is controlled by both a value obtained by integrators 119 and 130 integrating transmission power control signal TPC\_DBA which was  
20 extracted by RAKE combiners 123 and 134 and the time difference between the downlink signal transmission timing and the uplink signal reception timing measured by time difference measurers 501 and 502.

[0068]

25           If the time difference measured by time difference measurers 501 and 502 is large, mobile station M is judged to be far from base station A. In this case, base stations A and B reduce the offset values of offset adjusters 135 and 136 to reduce the amplification factor of amplifier

116, reducing the transmission power. On the contrary, if the time difference is small, mobile station M is judged to be near base station A and base stations A and B increase the offset values to increase the transmission power.

5 The time difference measured values used for offset adjustment are averaged to a certain degree so that they do not respond to instantaneous variations.

[0069]

As shown above, the base stations can perform more  
10 accurate downlink transmission power control through control by the transmission power control signal received and offset control based on the time difference between the transmission and receptions signals measured by time difference measurers 501 and 502 in addition to control  
15 by using offset adjusters 135, 136.

[0070]

#### [Effect of the Invention]

According to the present invention, the reception quality of the mobile station is maintained effectively,  
20 and preventing signals from being transmitted with excessive transmission power during a soft handover. Moreover, the total transmission power of the system decreases, whereas the system capacity and transmission quality increase.

#### 25 [BRIEF DESCRIPTION OF DRAWINGS]

[FIG.1] An outlined block diagrams of a transmission/reception apparatus according to Embodiment 1 of the present invention.

[FIG.2] A schematic diagram of transmission power of the base station according to Embodiment 1.

[FIG.3] A schematic diagram of reception power of the mobile station according to Embodiment 1.

5 [FIG.4] Outlined block diagrams of a CDMA base station according to Embodiment 2 of the present invention.

[FIG.5] Outlined block diagrams of a CDMA base station according to Embodiment 3 of the present  
10 invention.

[FIG.6] Outlined block diagrams of a conventional example of CDMA base station.

[FIG.7] A drawing showing how a handover takes place in the conventional example of CDMA base station.

15 [FIG.8] A schematic diagram of reception power of a mobile station of the conventional example of CDMA base station without transmission power control.

[FIG.9] A schematic diagram of reception power of the mobile station of the conventional example with  
20 transmission power control.

[FIG.10] A schematic diagram of transmission power of the base station of the conventional example with transmission power control.

[Description of the Symbols]

25 116 Base station A amplifier

119 Base station A integrator

122 Base station A\_SIR measurer

123 Base station A\_RAKE combiner

127 Base station B amplifier  
130 Base station B integrator  
133 Base station B\_SIR measurer  
134 Base station B\_RAKE combiner  
5 135 Base station A offset adjuster  
136 Base station B offset adjuster  
401 Base station A reception power measure  
402 Base station B reception power measures  
501 Base station A time difference measurer  
10 502 Base station B time difference measurer

## [NAME OF DOCUMENT] ABSTRACT

## [Abstract]

[Object] It is an object to reduce total transmission power of system while maintaining reception quality of reception station effectively and to improve capacity of system without executing transmission with excessive transmission power at the time of executing soft handover.

[Overcoming Means] The base station extracts a transmission power control signal mixed into an uplink reception signal and performs first transmission power control by amplifiers 116 and 127. At the same time, the base stations estimates the reception quality of the uplink reception signal by SIR measurers 122 and 133, and performs second transmission power control by adjusting the offset values of amplifiers 116 and 127 by offset adjusters 135 and 136 according to the estimation result. The second transmission power control is performed so as to reduce the transmission power when the base station is far from the mobile station and increase the transmission power when the base station is near the mobile station.

[Selected Drawings] FIG.1

[FIG.1]

BASE STATION A

117 DUPLEXER

116 AMPLIFIER

5 115 MODULATOR

114 SPREADER

113 FRAME FORMATTER

135 OFFSET ADJUSTER

119 INTEGRATOR

10 122 SIR MEASURER

120 DEMODULATOR

121 DESPREADER

123 RAKE COMBINER

15 MOBILE STATION M

101 FRAME FORMATTER

102 SPREADER

103 MODULATOR

104 AMPLIFIER

20 105 DUPLEXER

111 SIR MEASURER

112 AND

107 INTEGRATOR

110 RAKE COMBINER

25 109 DESPREADER

108 DEMODULATOR

BASE STATION B

128 DUPLEXER  
127 AMPLIFIER  
126 MODULATOR  
125 SPREADER  
5 124 FRAME FORMATTER  
136 OFFSET ADJUSTER  
130 INTEGRATOR  
133 SIR MEASURER  
131 DEMODULATOR  
10 132 DESPREADER  
134 RAKE COMBINER

[FIG.2]

BASE STATION TRANSMISSION POWER WITH TRANSMISSION POWER

15 CONTROL

BASE STATION B

BASE STATION A

TIME

20 [FIG.3]

MS RECEPTION POWER

DESIRED QUALITY

TIME

25 [FIG.4]

BASE STATION A

117 DUPLEXER

116 AMPLIFIER

115 MODULATOR  
114 SPREADER  
113 FRAME FORMATTER  
135 OFFSET ADJUSTER  
5 119 INTEGRATOR  
401 RECEPTION POWER MEASURER  
122 SIR MEASURER  
120 DEMODULATOR  
121 DESPREADER  
10 123 RAKE COMBINER

MOBILE STATION M

101 FRAME FORMATTER  
102 SPREADER  
15 103 MODULATOR  
104 AMPLIFIER  
105 DUPLEXER  
111 SIR MEASURER  
112 AND  
20 107 INTEGRATOR  
110 RAKE COMBINER  
109 DESPREADER  
108 DEMODULATOR

25 BASE STATION B  
128 DUPLEXER  
127 AMPLIFIER  
126 MODULATOR



125 SPREADER  
124 FRAME FORMATTER  
136 OFFSET ADJUSTER  
130 INTEGRATOR  
5 402 RECEPTION POWER MEASURER  
133 SIR MEASURER  
131 DEMODULATOR  
132 DESPREADER  
134 RAKE COMBINER  
10  
[FIG.5.]  
BASE STATION A  
117 DUPLEXER  
116 AMPLIFIER  
15 115 MODULATOR  
114 SPREADER  
113 FRAME FORMATTER  
135 OFFSET ADJUSTER  
119 INTEGRATOR  
20 501 TIME DIFFERENCE MEASURER  
122 SIR MEASURER  
120 DEMODULATOR  
121 DESPREADER  
123 RAKE COMBINER  
25  
MOBILE STATION M  
101 FRAME FORMATTER  
102 SPREADER

103 MODULATOR  
104 AMPLIFIER  
105 DUPLEXER  
111 SIR MEASURER  
5 112 AND  
107 INTEGRATOR  
110 RAKE COMBINER  
109 DESPREADER  
108 DEMODULATOR  
10  
BASE STATION B  
128 DUPLEXER  
127 AMPLIFIER  
126 MODULATOR  
15 125 SPREADER  
124 FRAME FORMATTER  
136 OFFSET ADJUSTER  
130 INTEGRATOR  
502 TIME DIFFERENCE MEASURER  
20 133 SIR MEASURER  
131 DEMODULATOR  
132 DESPREADER  
134 RAKE COMBINER  
25 [FIG.6]  
BASE STATION A  
17 DUPLEXER  
16 AMPLIFIER

15 MODULATOR  
14 SPREADER  
13 FRAME FORMATTER  
19 INTEGRATOR  
5 22 SIR MEASURER  
20 DEMODULATOR  
21 DESPREADER  
23 RAKE COMBINER

10 MOBILE STATION M  
1 FRAME FORMATTER  
2 SPREADER  
3 MODULATOR  
4 AMPLIFIER  
15 5 DUPLEXER  
11 SIR MEASURER  
12 AND  
7 INTEGRATOR  
10 RAKE COMBINER  
20 9 DESPREADER  
8 DEMODULATOR

BASE STATION B  
28 DUPLEXER  
25 27 AMPLIFIER  
26 MODULATOR  
25 SPREADER  
24 FRAME FORMATTER

30 INTEGRATOR  
33 SIR MEASURER  
31 DEMODULATOR  
32 DESPREADER  
5 34 RAKE COMBINER

[FIG.7]

BASE STATION A  
BASE STATION B

10

[FIG.8]

MS RECEPTION POWER  
COMBINATION  
DESIRED QUALITY

15 BASE STATION B  
BASE STATION A  
TIME

[FIG.9]

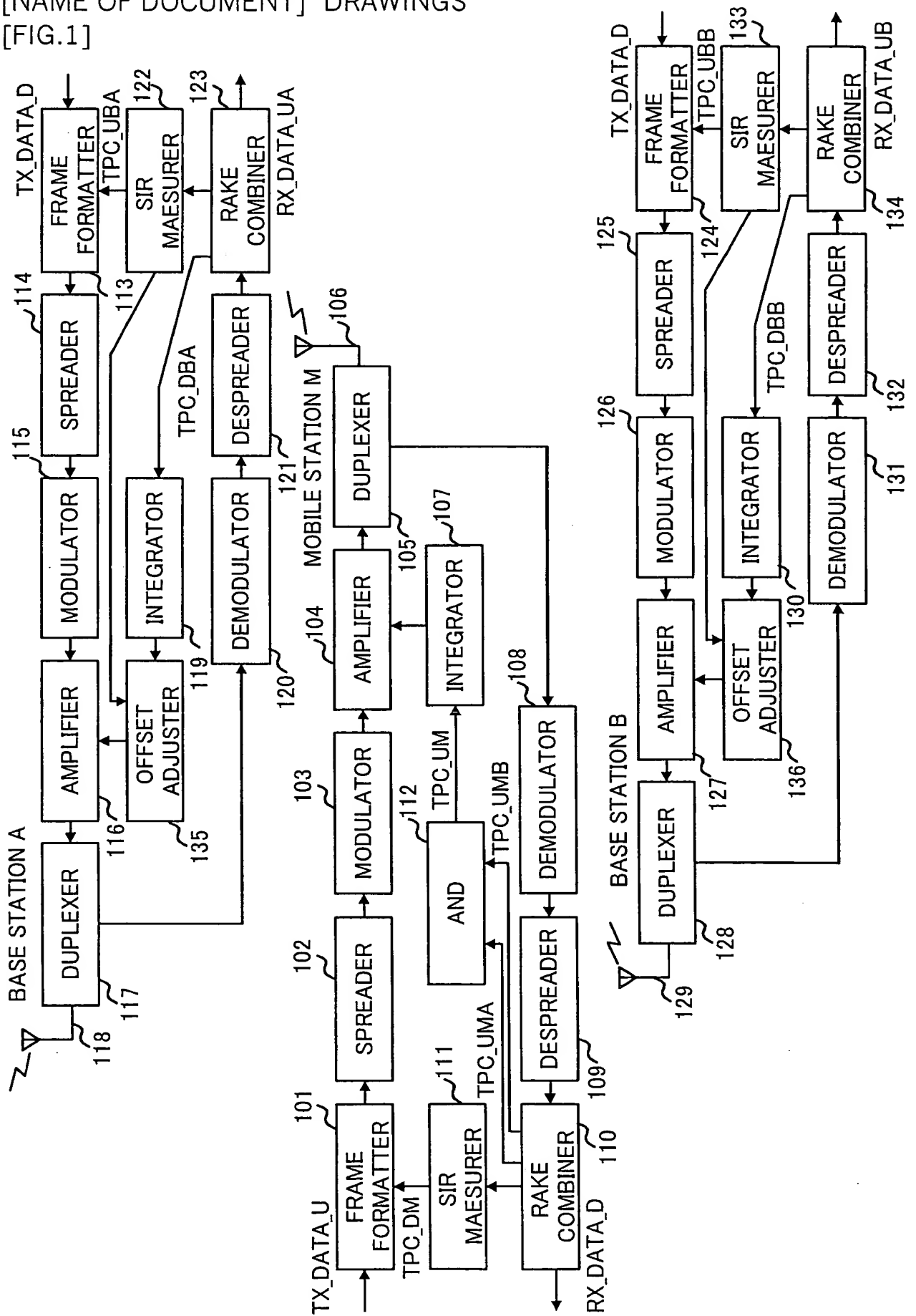
20 MS RECEPTION POWER  
DESIRED QUALITY  
TIME

[FIG.10]

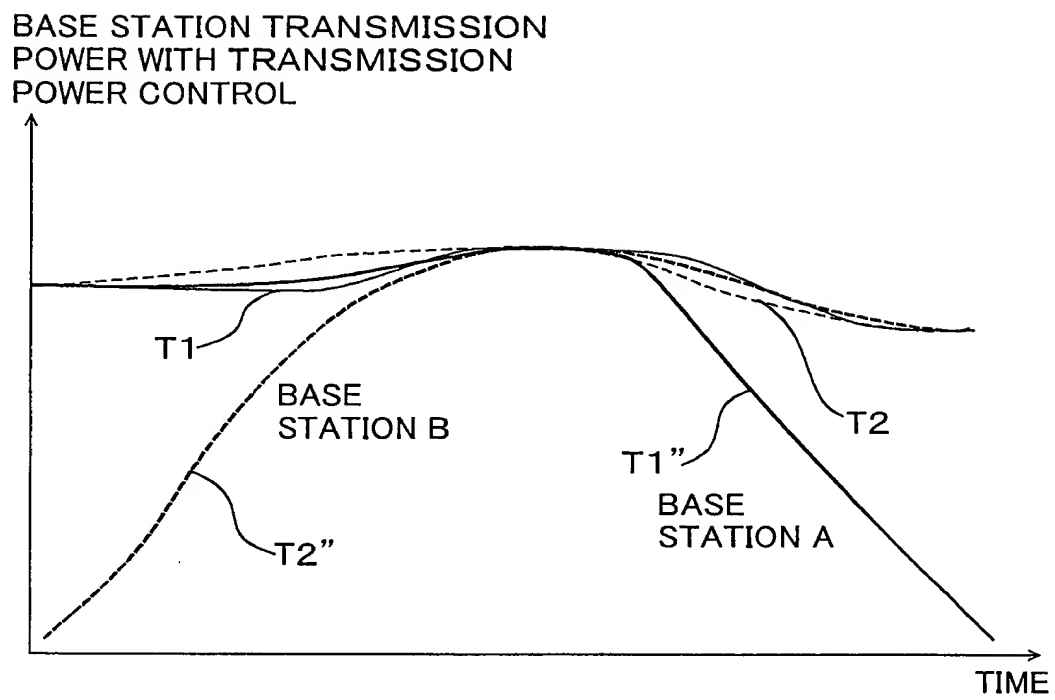
25 BASE STATION TRANSMISSION POWER WITH TRANSMISSION POWER  
CONTROL  
BASE STATION A  
BASE STATION B

TIME

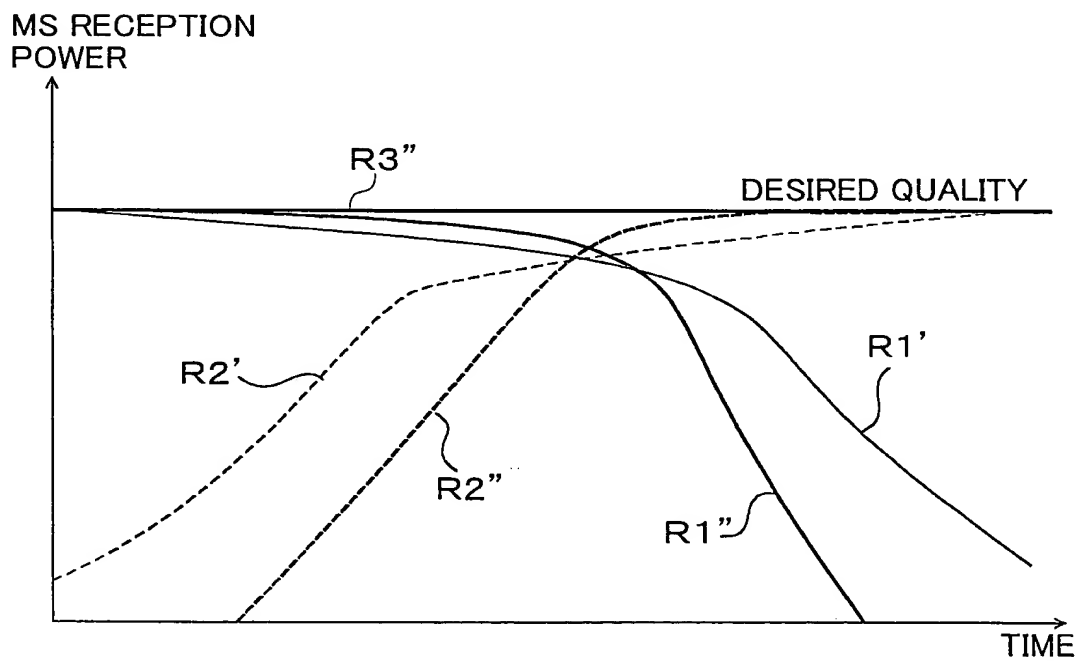
[NAME OF DOCUMENT] DRAWINGS  
[FIG.1]



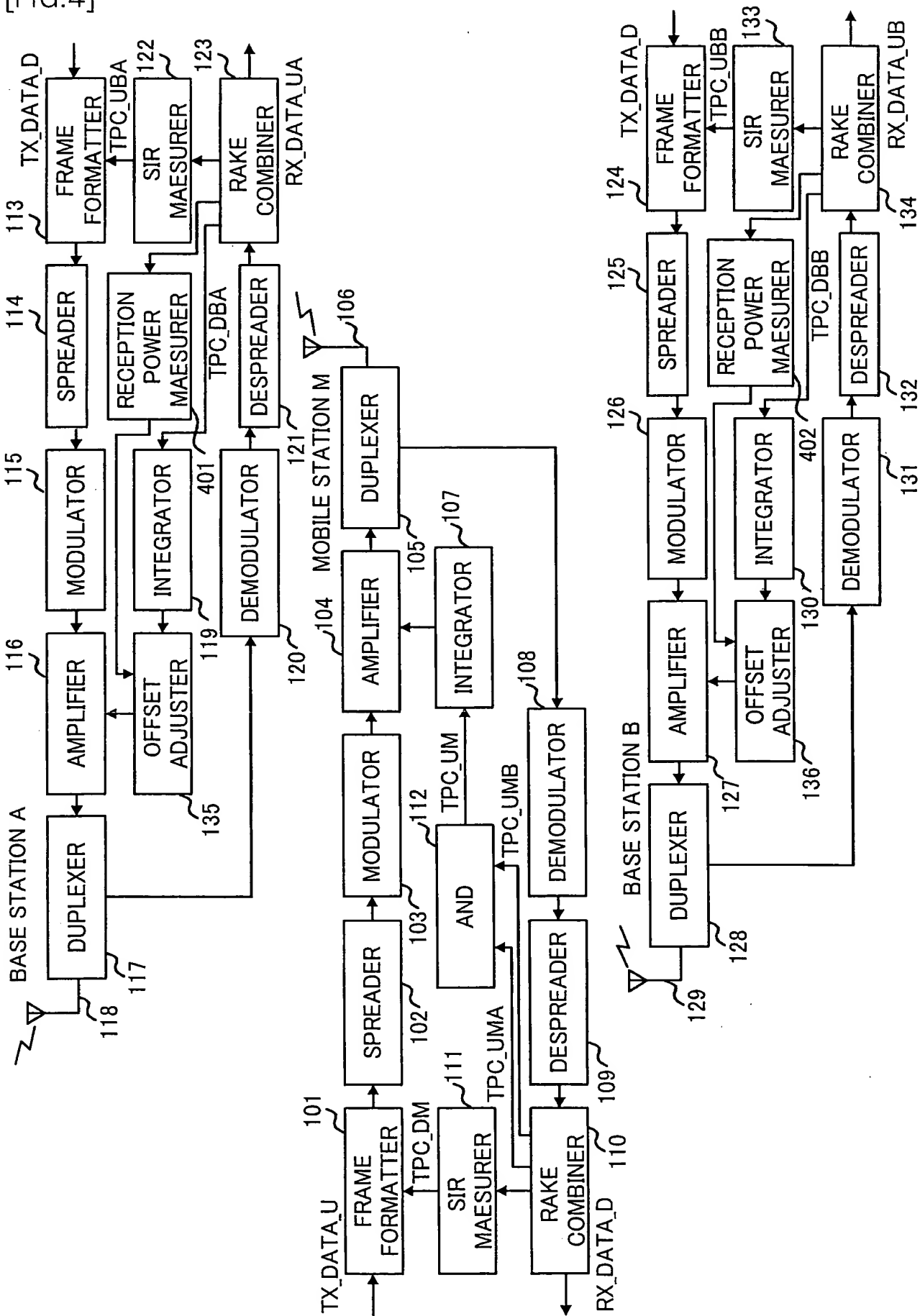
[FIG.2]



[FIG.3]

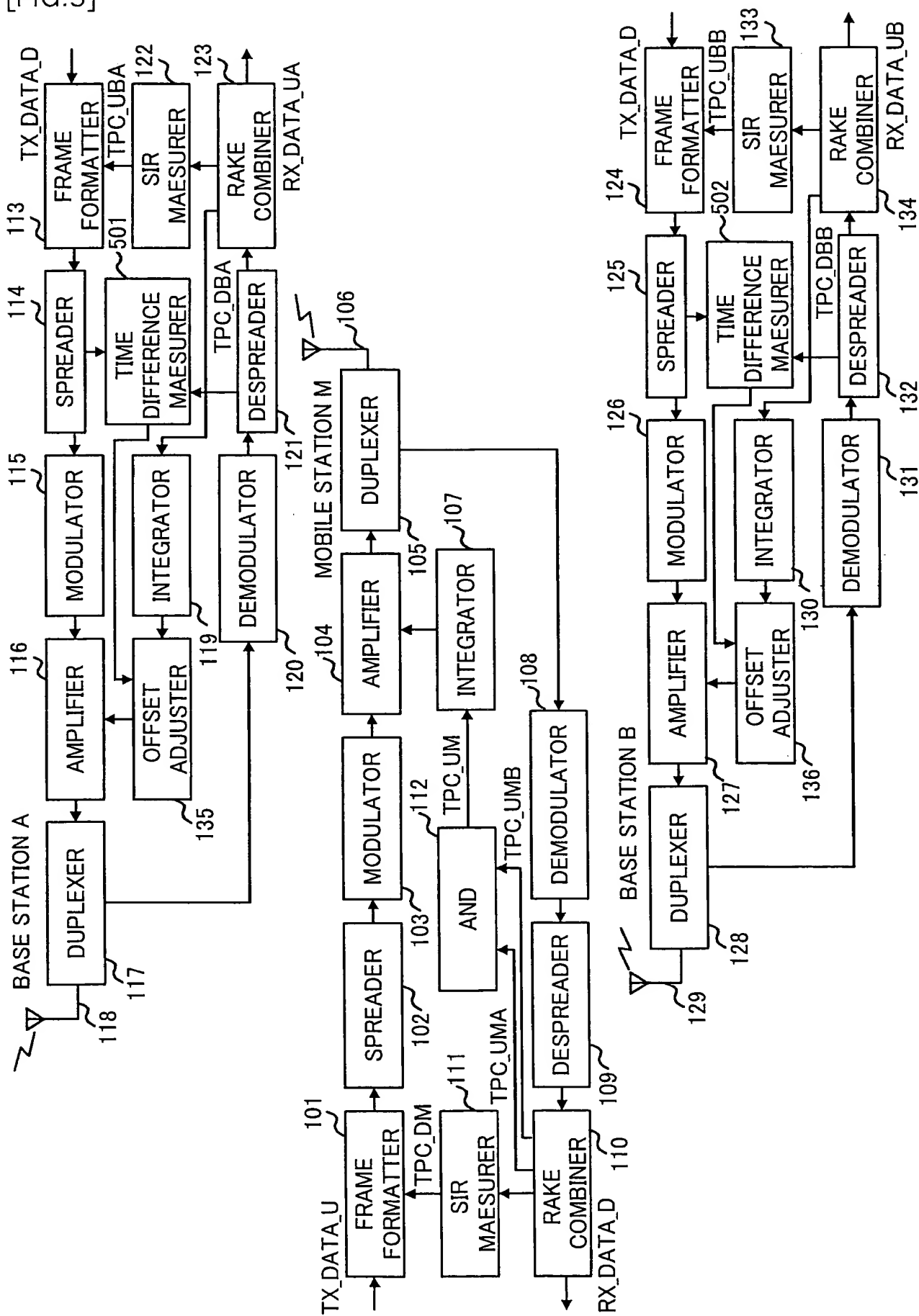


[FIG. 4]

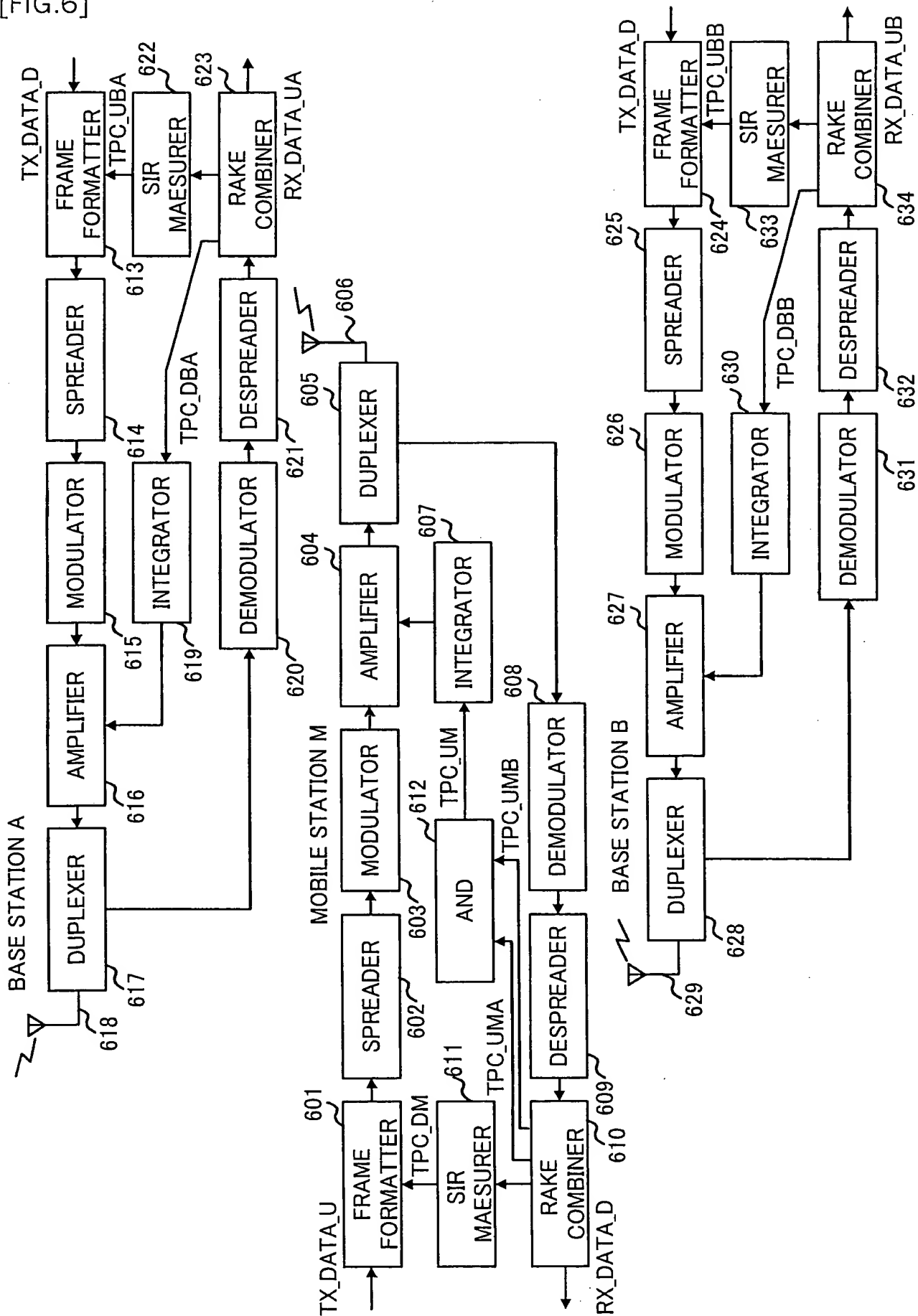




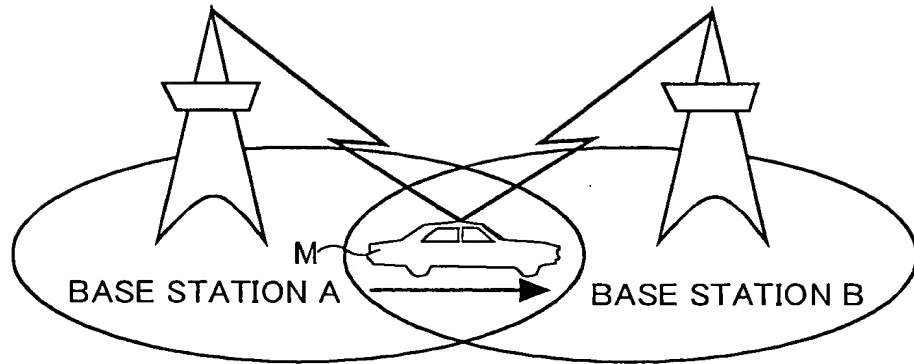
[FIG. 5]



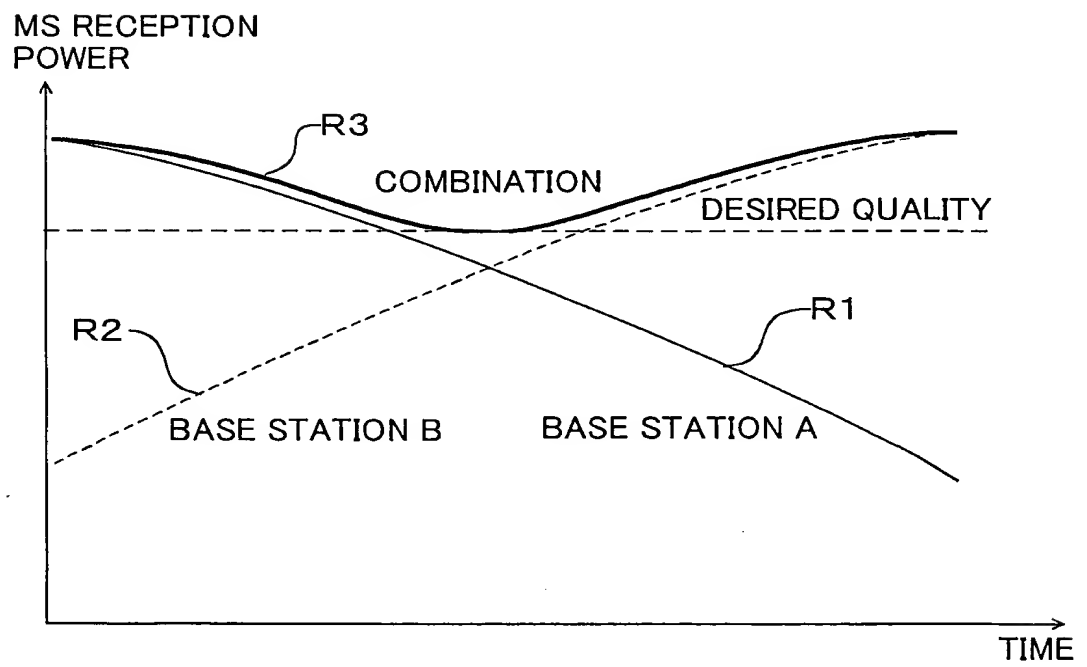
[FIG. 6]



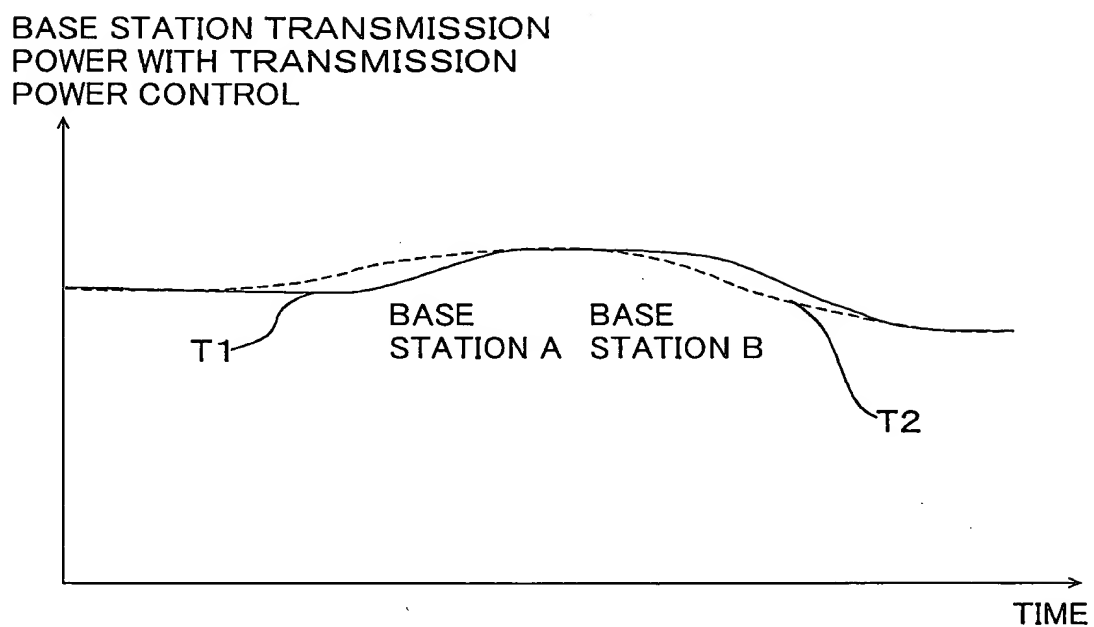
[FIG.7]



[FIG.8]



[FIG.9]



[FIG.10]

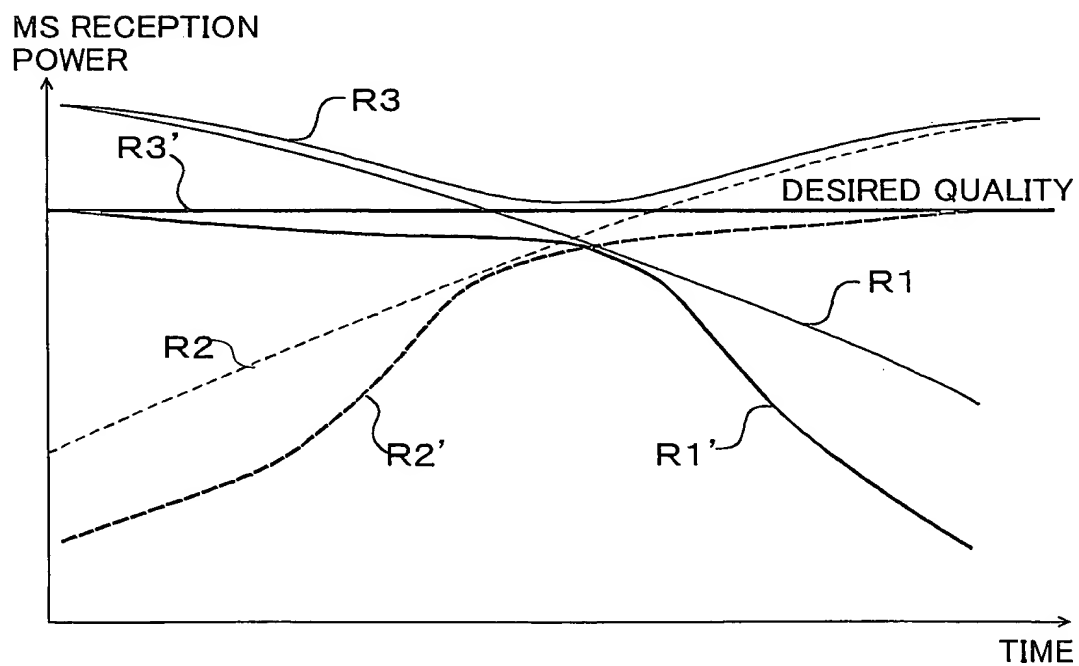


FIG.4